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(71) Applicant *(for all designated States except US)*: **PHILLIPS PETROLEUM COMPANY** [US/US]; 4th and Keller, Bartlesville, OK 74004 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **GERHOLD, Bruce, W.** [US/US]; Route 3, Box 8190, Bartlesville, OK 74003 (US). **THATCHER, Wayne, G.** [US/US]; Route 4, 200 Country Road 849, Brazoria, TX 77422 (US). **OWEN, Steven, A.** [US/US]; 4926 Berry Knoll Court, Kingwood, TX 77345 (US). **SNELLING, Ricky, E.** [US/US]; 5520 East 89th Court, Tulsa, OK 74137 (US).

(74) Agents: **RICHARDS, John** et al.; Ladas & Parry, 26 West 61st Sreet, New York, NY 10023 (US).

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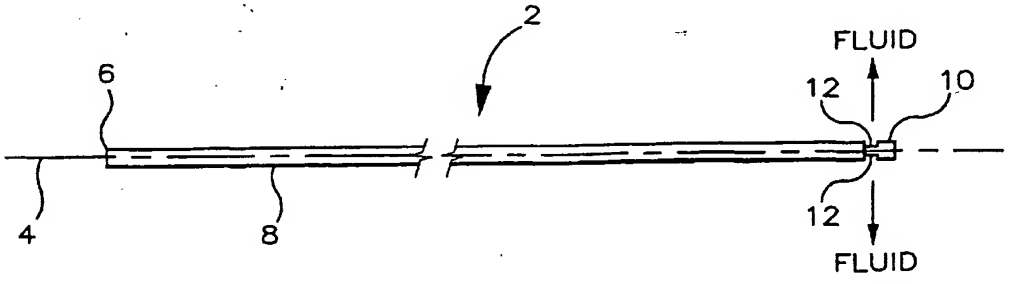
(54) Title: APPARATUS/METHOD FOR IN-PLACE CLEANING OF INDUSTRIAL FURNACE BURNERS



(57) Abstract: An elongated lance (2) having an inlet (6) for receiving a fluid and an outlet (12) for discharging the fluid in a direction which is substantially perpendicular to the longitudinal axis (4) of the lance. The elongated lance is used to clean fouled burner tip apertures (32) of an industrial furnace burner (18) without substantially disassembly the burner.

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APPARATUS/METHOD FOR IN-PLACE CLEANING OF INDUSTRIAL FURNACE BURNERS

The present invention relates to a novel lance useful for cleaning industrial furnace burners. In another aspect, this invention relates to a method for cleaning an industrial furnace burner without substantially disassembling the burner.

Background of the Invention

Industrial furnaces, such as those employed in the production of ethylene, typically comprise a multitude of individual burners attached to, and extending through, the furnace wall. Each burner receives a charge of a hydrocarbon fuel, mixes the fuel with combustion air, and disperses the air/fuel mixture into the furnace where it is combusted.

One problem encountered in operating industrial furnace burners is fouling of burner components. Such fouling is typically caused by heavy hydrocarbons in the hydrocarbon fuel charged to the burner. These heavy hydrocarbons can cause the buildup of undesirable carbonaceous deposits in the burner and especially on the burner tip, where the fuel/air mixture exits the burner. Burner fouling can dramatically decrease the efficiency of an industrial furnace. Therefore, periodic cleaning of fouled burners is required.

Conventional methods of cleaning industrial furnace burners require that each burner be disassembled and removed from the furnace wall. Once removed from the furnace wall, the undesirable deposits on the burner tip are manually removed by blasting, brushing, and/or hammering. Although such methods are effective for cleaning the burner, they are very inefficient.

One inefficiency present in conventional methods of cleaning industrial furnace burners is the amount of labor required to disassemble and remove the burner from the furnace. Another inefficiency is the amount of labor required to manually clean the burner tip. A further inefficiency stems from the fact that while the burner is removed from the furnace wall, relatively cool, external air is drawn into the furnace.

Thus, there exists a need for an improved burner cleaning method and/or apparatus.

Summary of the Invention

It is desirable to provide an apparatus useful for cleaning industrial furnace burners.

Again it is desirable to provide a method for the in-place cleaning of industrial furnace burners.

Further objects and advantages of the present invention will become apparent from consideration of the detailed description of the invention and appended claims.

Accordingly, in one embodiment of the invention an elongated lance having a longitudinal lance axis is provided. The lance comprises an inlet for receiving a fluid and an outlet for discharging the fluid. The elongated lance is capable of conducting the fluid from the inlet to the outlet in a flow direction which is substantially parallel to the longitudinal lance axis. The outlet is capable of discharging the fluid in a flow direction which is substantially perpendicular to the longitudinal lance axis.

In another embodiment of the invention a lance is provided. The lance comprises an elongated tubular main member having a longitudinal main member axis, a first end, and a second end and an end piece rigidly connected in fluid flow communication with the second end of the elongated tubular main member. The end piece comprises an end piece inlet for receiving the fluid from the second end of the elongated tubular main member, an end piece outlet for discharging the fluid, and a flow redirecting surface located between the end piece inlet and the end piece outlet.

A still further embodiment of the present invention is a process for cleaning an industrial furnace burner having burner tip apertures which are at least partially fouled with undesirable deposits. The process comprises the steps of (a) inserting an elongated lance having a lance inlet and a lance outlet into an external burner orifice; (b) manipulating the elongated lance through a longitudinal fuel passageway within the industrial furnace burner until the lance outlet is substantially aligned with the fouled burner tip apertures; (c) charging a fluid to the elongated lance for a cleaning period sufficient to remove at least a portion of the undesirable deposits from the burner tip apertures.

Brief Description of the Drawings

In the accompanying drawings:

FIG. 1 is a side view showing a lance with an end piece.

FIG. 2 is an exploded view showing a tubular main member and end piece of a lance.

FIG. 3 is a top view showing an end piece.

FIG. 4 is a side view showing an end piece.

FIG. 5 is an end view showing an end piece.

FIG. 6 is a perspective view showing the front of an industrial furnace burner.

FIG. 7 is a perspective view showing the back of an industrial furnace burner.

FIG. 8 is a cross-sectional view of an industrial furnace burner.

Detailed Description of the Invention

In an embodiment of the present invention an elongated lance useful for cleaning industrial furnace burners is provided.

Referring now to FIG. 1. A lance 2 comprises a lance inlet 6, a tubular main member 8, and an end piece 10. End piece 10 is rigidly fixed to tubular main member 8 by any suitable means, such as welding. Lance inlet 6, tubular main member 8, and end piece 10 are substantially aligned along longitudinal lance axis 4.

Lance 2 is capable of having a high-pressure fluid enter lance inlet 6 and flow through tubular main member 8 towards end piece 10 in a flow direction which is substantially parallel to longitudinal lance axis 4. The fluid exits lance 2 at end piece 10 through end piece outlets 12 in a flow direction which is substantially perpendicular to longitudinal lance axis 4.

It is preferred for lance 2 to have a relatively small external diameter which allows lance 2 to enter an external orifice of an industrial furnace burner and pass through the fuel passageway of the burner. As used herein, with respect to lance 2, the term "external diameter" shall mean the maximum external dimension of lance 2 as measured perpendicular to longitudinal lance axis 4 on a line running through longitudinal lance axis 4.

The external diameter of lance 2 is preferably from about 0.01 inches to about 1 inch, more preferably from about 0.05 inches to about 0.5 inches, still more preferably from about 0.10 inches to about 0.25 inches, and most preferably from 0.15 inches to 0.20 inches.

The length of lance 2 can be any length suitable to reach from an external orifice of an industrial furnace burner, through the fuel passageway of the burner, and to the burner tip where the fuel/air mixture is discharged from the burner. Preferably, the length of lance 2, measured from lance inlet 6 to the opposite end of end piece 10, is from about 5 inches to about 200 inches, more preferably from about 10 inches to about 100 inches,

still more preferably from about 20 inches to about 50 inches, and most preferably from 30 inches to 40 inches.

It is preferred for the ratio of the length of lance 2 to the external diameter of lance 2 to be relatively large. Preferably, the length to external diameter ratio of lance 2 is from about 20:1 to about 5000:1, more preferably from about 100:1 to about 1000:1, still more preferably from about 200:1 to about 500:1, and most preferably from 225:1 to 250:1.

Tubular main member 8 preferably has a wall thickness of from about 0.000001 inches to about 0.1 inches, more preferably from about 0.0001 inches to about 0.01 inches, still more preferably from about 0.0005 inches to about 0.005 inches, and most preferably about 0.0015 inches.

Lance 2 can be made of any material of suitable strength and rigidity. Preferably, lance 2 is made of a rigid material which allows the lance to maintain structural integrity while being charged with steam at a pressure of from about 50 psig to about 500 psig, more preferably from about 100 psig to about 250 psig, and most preferably from 125 psig to 175 psig and at a rate of from about 50 pounds/hr to about 500 pounds/hr, preferably from about 100 pounds/hr to about 300 pounds/hr, and most preferably from 150 pounds/hr to 250 pounds/hr. Most preferably, lance 2 is made of stainless steel.

Referring now to FIGS. 2, 3, 4, and 5. End piece 10 has a first end 9 and a second end 11. First end 9 has an external diameter which allows it to fit snugly within the internal diameter of tubular main member 8. Second end 11 has an external diameter which is substantially the same as the external diameter of cylindrical main member 8. End piece 10 preferably has a length of from about 0.01 inches to about 2 inches, more preferably from about 0.1 inches to about 1 inch, and most preferably from 0.2 inches to 0.5 inches.

End piece 10 has at least two opposing grooves first which create end piece inlets 14, end piece outlets 13, and flow redirecting surfaces 16. The grooves in first end 9 extend in a direction parallel to longitudinal lance axis 4. The grooves in second end 11 continue to extend longitudinally but also curve away from longitudinal lance axis 4 towards the external diameter of second end 11.

Along the plane where first end 9 abutts second end 11, flow redirecting surfaces 16 are substantially parallel to longitudinal lance axis 4. Along the edge where flow redirecting surface 16 intersects with the external diameter of second end 11, the slope of

flow redirecting surfaces 16 are substantially perpendicular to longitudinal axis 4.

Fluid flowing through tubular main member 8 in a flow direction substantially parallel to longitudinal lance axis 4 enters end piece 10 through end piece inlets 14, contacts flow redirecting surfaces 16, and exists end piece outlets 13 in a flow direction which is substantially perpendicular to longitudinal lance axis 4.

In an embodiment of the present invention, a process is provided for the in-place cleaning of an industrial furnace burner.

Referring now to FIG. 6. A burner 18 comprises an external housing 20 which is rigidly connected to flange 22. Flange 22 is placed over an opening in the wall of an industrial furnace and bolted to the furnace wall. Elongated throat 28 and burner tip 30 extend into the furnace through the opening in the furance wall. Air intakes 26 provide combustion air to burner18.

Referring now to FIG. 7. Fuel enters burner 18 at a fuel intake assembly 34 via a fuel line 24. Fuel intake assembly 34 is connected to a removable base plate 42, which is demountably attached to external housing 20. Fuel intake assembly 34 comprises a longitudinal orifice 38 and, optionally, a transverse orifice 36. If fuel intake assembly comprises both transverse orifice 36 and longitudinal orifice 40, it is preferred for fuel line 24 to be connected with transverse orifice 36, while longitudinal orifice 38 is plugged with an orifice plug 40 during normal operation. If fuel intake assembly 34 does not have transverse orifice 36, fuel line 24 can be connected to longitudinal orifice 38 during normal operation.

Referring now to FIG. 8. After the fuel enters fuel intake assembly 34, it is conducted to a fuel nozzle 44. The fuel exits fuel nozzle 44 at fuel nozzle exit 46 and is injected at high velocity into elongated throat 28. When the fuel enters elongated throat 28 it draws in combustion air which enters burner housing 20 through air intakes 26. The fuel/air mixture is conducted through elongated throat 28 towards burner tip 30. The fuel/air mixture exits burner tip 30 via a plurality of burner tip apertures 32 in a direction which is substantially perpendicular to a longitudinal burner axis 52.

Longitudinal orifice 38, fuel nozzle 44, elongated throat 28, and burner tip 30 are each substantially aligned along longitudinal burner axis 52. Alignment of these components is assured by rigidly affixing them to removable base plate 42. Elongated throat 28 is rigidly affixed to removable base plate 42 via a throat base 50 and connector

rods 48.

A "longitudinal fuel passageway" is created by longitudinal orifice 38, fuel nozzle 44, elongated throat 28 and burner tip 30. The longitudinal fuel passageway typically has a relatively small internal diameter. As used herein, with respect to the longitudinal fuel passageway, the term "internal diameter" shall mean the minimum internal dimension of the longitudinal fuel passageway as measured perpedicular to the longitudinal burner axis on a line running through the longitudinal burner axis. Typically, the internal diameter of the longitudinal fuel passage way is measured at the narrowest interval section of fuel nozzle 44. The internal diameter of the longitudinal fuel passageway is preferably from about 0.01 inches to about 1 inch, more preferably from about 0.05 inches to about 0.5 inches, still more preferably from about 0.10 inches to about 0.25 inches, and most preferably from 0.15 inches to 0.20 inches.

The distance from longitudinal orifice 38 to burner tip apertures 32, as measured parallel to longitudinal burner axis 52, is preferably from about 5 inches to about 100 inches, more preferably from about 10 inches to about 50 inches, and most preferably from 20 inches to 30 inches.

After extended use, burner tip apertures 32 can become fouled with undesirable deposits. In the past, in order to clean burner tip apertures 32, removable base plate 42 was unbolted and removed from external housing 20. Elongated throat 28 and burner tip 30 were then removed from external housing 20 for a manual cleaning. Conventional burner cleaning practice was a time-consuming procedure which often required more than 1 man-hour of labor per burner. In addition, conventional burner cleaning practice allowed relatively cool, external air to flow through the back of external housing 20 and into the furnace.

In accordance with the present inventive cleaning procedure, described herein, burner apertures 32 are cleaned in a minimal amount of time and without allowing a substantial amount of external air to be drawn into the furnace.

Preferably, fuel flow to burner 18 is terminated prior to cleaning. After burner 18 is shut down, an elongated lance having a lance inlet and a lance outlet may be inserted through longitudinal orifice 38 and along longitudinal burner axis 52, until the lance outlet is substantially aligned with burner tip apertures 32. If fuel line 24 is attached to transverse orifice 36, orifice plug 40 must be removed before inserting the elongated

lance into longitudinal orifice 38. If fuel line 24 is attached to longitudinal orifice 38, fuel line 24 must be removed prior to insertion of the elongated lance into longitudinal orifice 38.

Once the lance outlets are aligned with burner tip apertures 30, a high-pressure fluid capable of removing undesirable deposits from burner tip apertures 32 is charged to the lance. The elongated lance can then be rotated around its longitudinal axis and manipulated along its longitudinal to ensure proper cleaning of all burner tip apertures 32.

The period during which a fluid is charged to the elongated lance can be any period which allows for at least a portion, preferably a substantial portion, of the undesirable deposits fouling burner tip apertures 32 to be removed. Preferably, the fluid is charged to the elongated lance for from about 0.5 minutes to about 60 minutes, more preferably from about 5 minutes to about 30 minutes, most preferably from 10 minutes to 20 minutes.

The fluid charged to the elongated lance is preferably steam. The pressure of the fluid charged to the elongated lance is preferably from about 50 psig to about 500 psig, still more preferably from about 100 psig to about 250 psig, and most preferably from 125 psig to 175 psig. The fluid preferably exits the elongated lance at high velocity. The velocity of the fluid exiting the lance outlet is preferably greater than 50% of sonic velocity, more preferably greater than 80% of sonic velocity, and most preferably substantially sonic velocity. As used herein, the term "sonic velocity" shall mean the sonic velocity of the fluid exiting the lance at the exit temperature.

Once a portion of, and preferably substantially all, deposits have been removed from burner apertures 32, the charging of the fluid to the elongated lance can be terminated. The elongated lance may then be withdrawn from burner 18 through longitudinal orifice 38, and orifice plug 40, or optionally fuel line 24, can be reattached to longitudinal orifice 38. Burner 18 can then be restarted by charging fuel to fuel line24.

The elongated lance employed in the inventive burner cleaning method of the present invention can be any elongated lance which is capable of passing through the longitudinal fuel passageway of a burner and discharging a fluid, at high velocity, in a direction which is substantially perpendicular to the longitudinal axis of the elongated lance. Preferably, the elongated lance employed in the inventive burner cleaning method of the present invention is the inventive lance described herein.

The inventive in-place burner cleaning procedure described herein can decrease the amount of labor required to clean an industrial furnace burner to 1/4 that of conventional procedures. In addition, the inventive burner cleaning procedure described herein allows relatively little external air to enter the furnace during cleaning.

While this invention has been described in detail for the purpose of illustration, it should not be construed as limited thereby but intended to cover all changes and modifications within the spirit and scope thereof.

CLAIMS

1. An elongated lance having a longitudinal lance axis, said elongated lance comprises an inlet for receiving a fluid and an outlet for discharging said fluid, wherein said elongated lance is capable of conducting said fluid from said inlet to said outlet in a flow direction which is substantially parallel to said longitudinal lance axis, and wherein said outlet is capable of discharging said fluid in a flow direction which is substantially perpendicular to said longitudinal lance axis.

2. An elongated lance according to claim 1, wherein the external diameter of said elongated lance is from about 0.01 inches to about 1 inch.

3. An elongated lance according to claim 2, wherein the ratio of the length of said elongated lance to the external diameter of said elongated lance is from about 20:1 to about 5000:1.

4. An elongated lance according to claim 1, wherein the external diameter of said elongated lance is from about 0.05 inches to about 0.5 inches.

5. An elongated lance according to claim 4, wherein the ratio of the length of said elongated lance to the external diameter of said elongated lance is from about 100:1 to about 1000:1.

6. An elongated lance according to claim 5, wherein said elongated lance comprises more than one said outlet.

7. An elongated lance according to claim 1, wherein the external diameter of said elongated lance is from about 0.10 inches to about 0.25 inches.

8. An elongated lance according to claim 7, wherein the ratio of the length of said elongated lance to the external diameter of said elongated lance is from about 200:1 to about 500:1.

9. An elongated lance according to claim 8, wherein said elongated lance comprises two opposing outlets capable of discharging said fluid in substantially opposite directions.

10. A lance comprising:

an elongated tubular main member having a first end for receiving a fluid, a second end for discharging said fluid, and a longitudinal main member axis, wherein said elongated tubular main member is capable of conducting said fluid in a flow direction which is substantially parallel to said longitudinal main member axis; and

an end piece rigidly connected in fluid flow communication with said second end

of said elongated tubular main member, wherein said end piece comprises an end piece inlet for receiving said fluid from said second end of said elongated tubular main member, an end piece outlet for discharging said fluid from said end piece, and a flow redirecting surface located between said end piece inlet and said end piece outlet, wherein said end piece is capable of redirecting the flow direction of said fluid from an inlet flow direction which is substantially parallel to said longitudinal main member axis to an outlet flow direction which is substantially perpendicular to said longitudinal main member axis.

11. A lance according to claim 10, wherein the external diameter of said lance is from about 0.01 inches to about 1 inch.

12. A lance according to claim 11, wherein the ratio of the length of said elongated lance to the external diameter of said elongated lance is from about 20:1 to about 5000:1.

13. A lance according to claim 10, wherein the external diameter of said lance is from about 0.05 inches to about 0.5 inches.

14. A lance according to claim 13, wherein the ratio of the length of said elongated lance to the external diameter of said elongated lance is from about 100:1 to about 1000:1.

15. A lance according to claim 14, wherein said end piece comprises more than one said outlet.

16. A lance according to claim 10, wherein the external diameter of said lance is from about 0.10 inches to about 0.25 inches.

17. A lance according to claim 16, wherein the ratio of the length of said elongated lance to the external diameter of said elongated lance is from about 200:1 to about 500:1.

18. An elongated lance according to claim 17, wherein said end piece comprises two opposing outlets capable of discharging said fluid in substantially opposite directions.

19. A process for cleaning an industrial furnace burner having burner tip apertures which are at least partially fouled with undesirable deposits, said process comprises:

(a) inserting an elongated lance having a lance inlet and a lance outlet into an external burner orifice;

(b) manipulating said elongated lance through a longitudinal fuel passageway within said industrial furnace burner until said lance outlet is substantially aligned with said burner tip apertures;

(c) charging a fluid to said elongated lance for a cleaning period sufficient to

remove at least portion of the undesirable deposits from the burner tip apertures.

20. A process according to claim 19, wherein said fuel passageway is substantially centered around a longitudinal burner axis.

21. A process according to claim 20, wherein said fuel passageway has an internal diameter of from about 0.01 inches to about 1 inch.

22. A process according to claim 21, wherein the distance from said external burner orifice to said burner tip apertures, measured parallel to said longitudinal burner axis, is from about 5 inches to about 100 inches.

23. A process according to claim 22, wherein the pressure of said fluid charged to said elongated lance is from about 50 psig to about 500 psig.

24. A process according to claim 23, wherein said fluid exits said lance outlet at a velocity greater than about 50% of sonic velocity.

25. A process according to claim 24, wherein said fluid exits said lance outlet in a flow direction which is substantially perpendicular to said longitudinal burner axis.

26. A process according to claim 25, wherein said fluid is steam.

27. A process according to claim 19, wherein said fuel passageway is substantially centered around a longitudinal burner axis.

28. A process according to claim 27, wherein said fuel passageway has an internal diameter of from about 0.05 inches to about 0.5 inches.

29. A process according to claim 28, wherein the distance from said external burner orifice to said burner tip apertures, measured parallel to said longitudinal burner axis, is from about 10 inches to about 50 inches.

30. A process according to claim 29, wherein the pressure of said fluid charged to said elongated lance is from about 100 psig to about 250 psig.

31. A process according to claim 30, wherein said fluid exits said lance outlet at a velocity greater than about 80% of sonic velocity.

32. A process according to claim 31, wherein said fluid exits said lance outlet in a flow direction which is substantially perpendicular to said longitudinal burner axis.

33. A process according to claim 32, wherein said elongated lance has more than one said outlet.

34. A process according to claim 33, wherein said fluid is steam.

35. A process according to claim 19, wherein said fuel passageway is substantially

centered around a longitudinal burner axis.

36. A process according to claim 35, wherein said fuel passageway has an internal diameter of from about 0.10 inches to about 0.25 inches.

37. A process according to claim 36, wherein the distance from said external burner orifice to said burner tip apertures, measured parallel to said longitudinal burner axis, is from about 20 inches to about 30 inches.

38. A process according to claim 37,wherein the pressure of said fluid charged to said elongated lance is from about 125 psig to about 175 psig.

39. A process according to claim 37, wherein said fluid exits said lance outlet at substantially sonic velocity.

40. A process according to claim 39, wherein said fluid exits said lance outlet in a flow direction which is substantially perpendicular to said longitudinal burner axis.

41. A process according to claim 40, wherein said elongated lance has two opposing outlets capable of discharging said fluid in substantially opposite directions.

42. A process according to claim 41, wherein said fluid is steam.

43. A process according to claim 19, wherein said elongated lance is the elongated lance of claim 1.

44. A process according to claim 19, wherein said elongated lance is the elongated lance of claim 10.

45. A process according to claim 33, wherein said elongated lance is the lance of claim 1.

46. A process according to claim 33, wherein said elongated lance is the lance of claim 10.

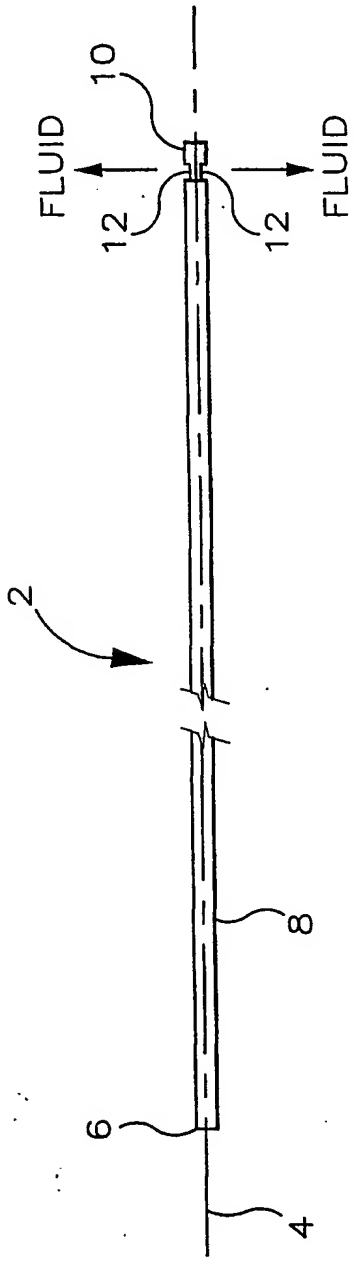

FIG. 1

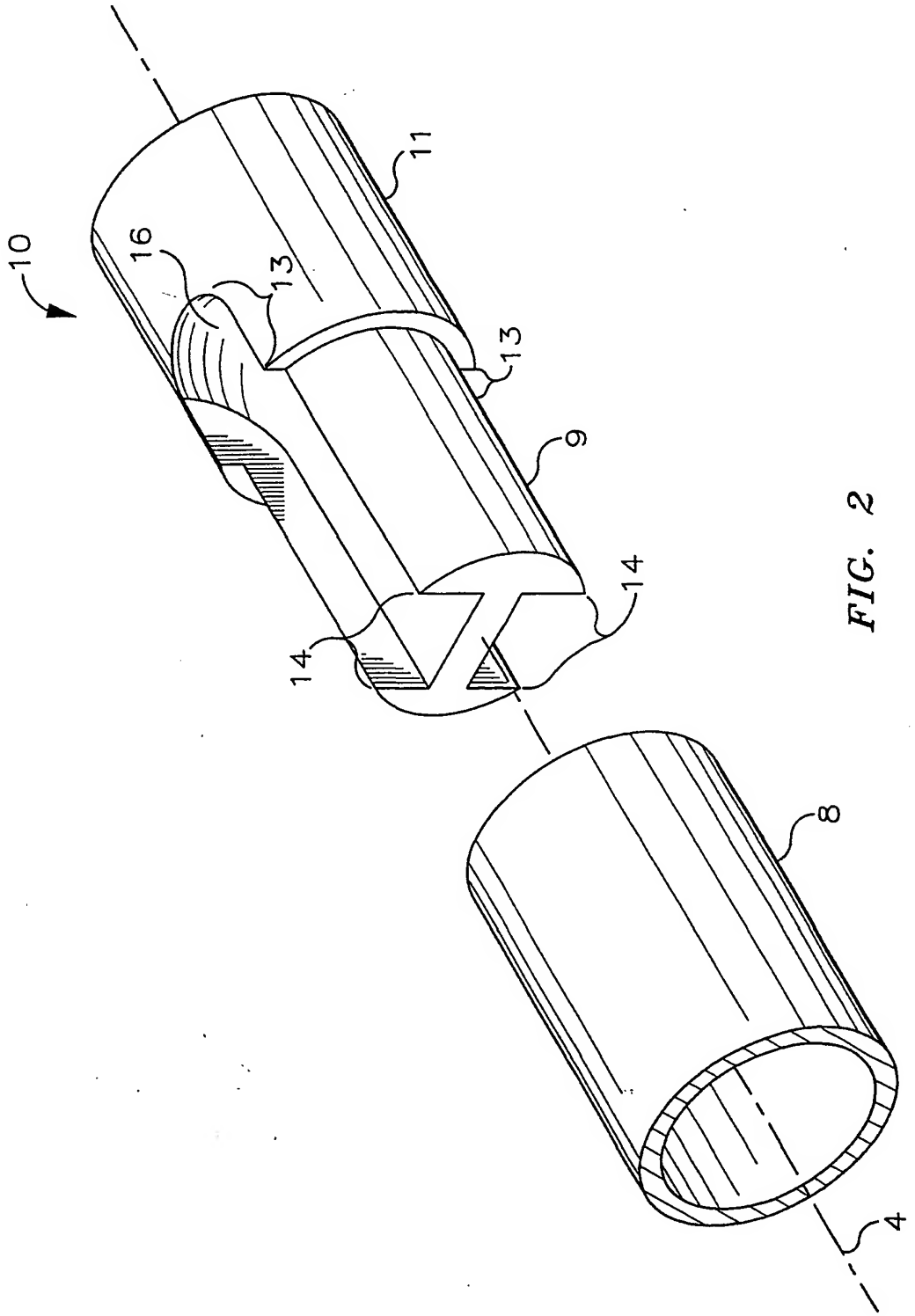

FIG. 2

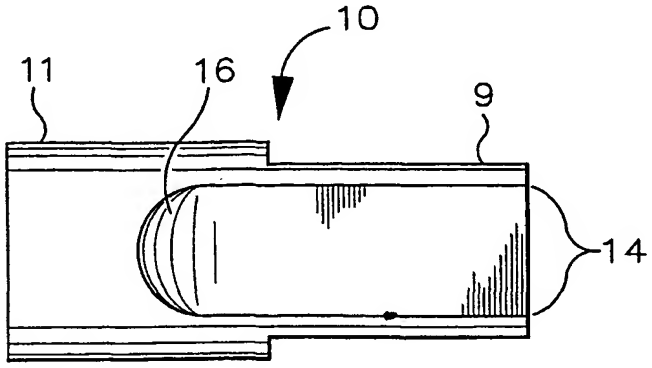

FIG. 3

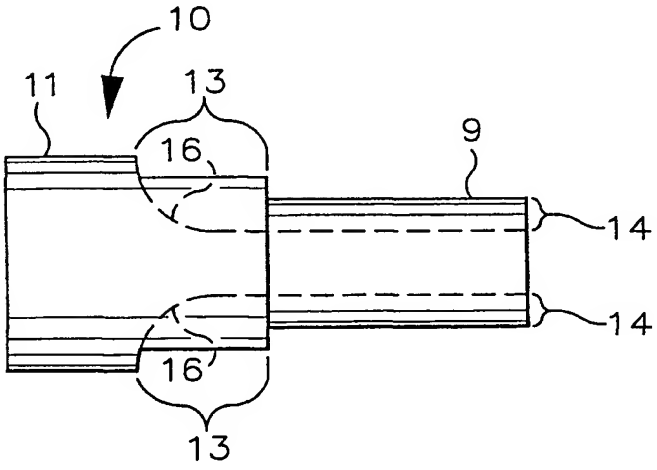

FIG. 4

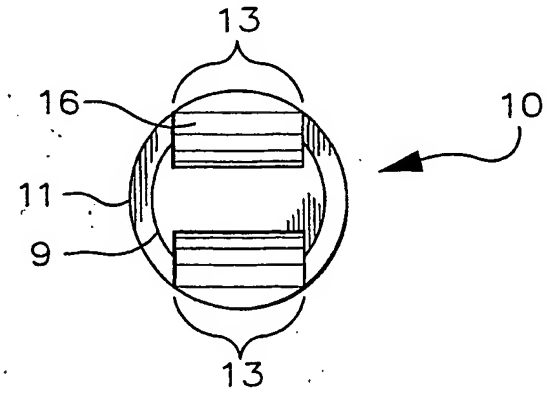

FIG. 5

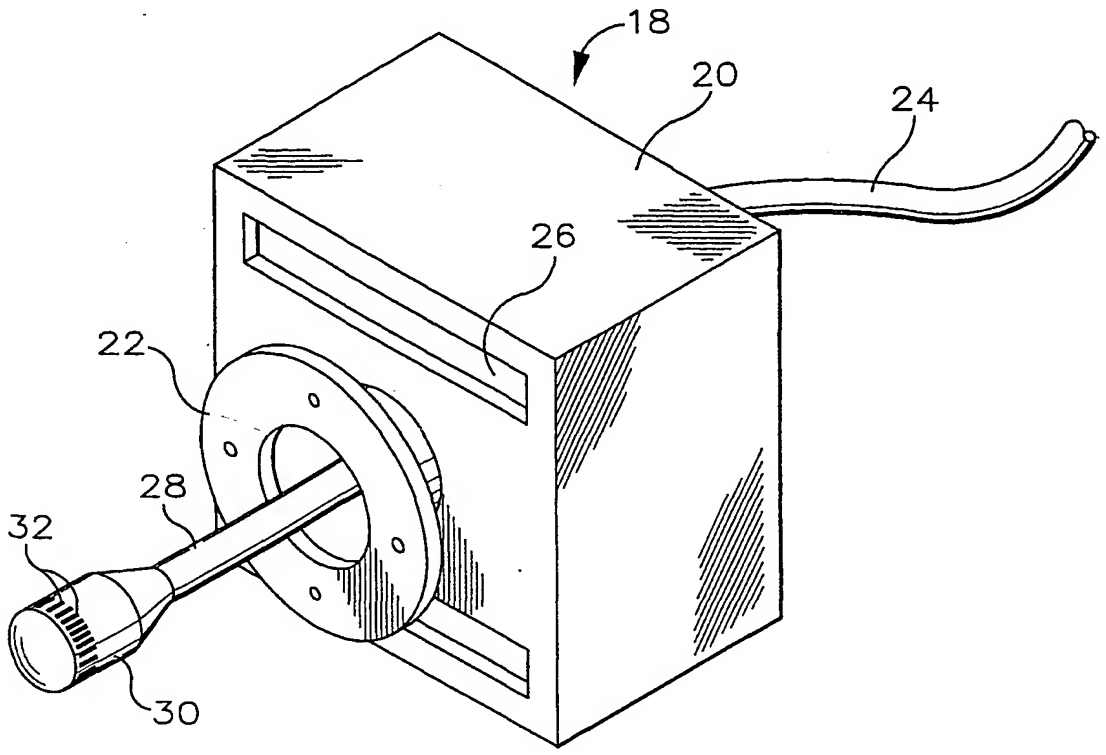

FIG. 6

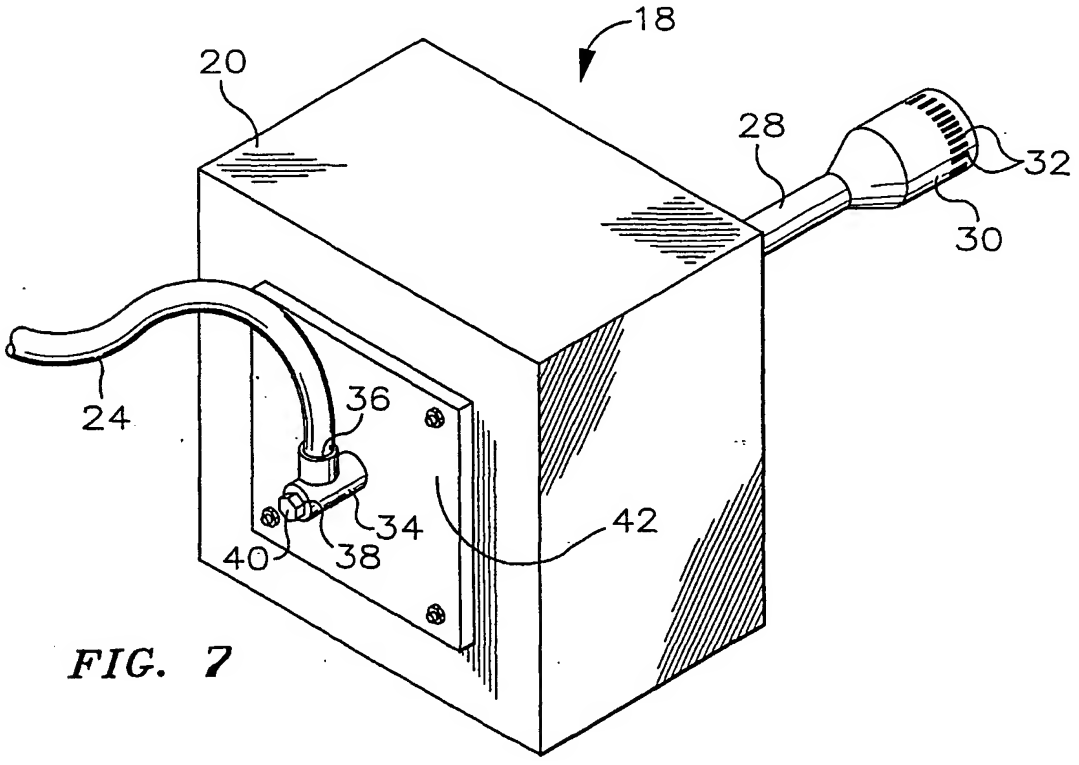

FIG. 7

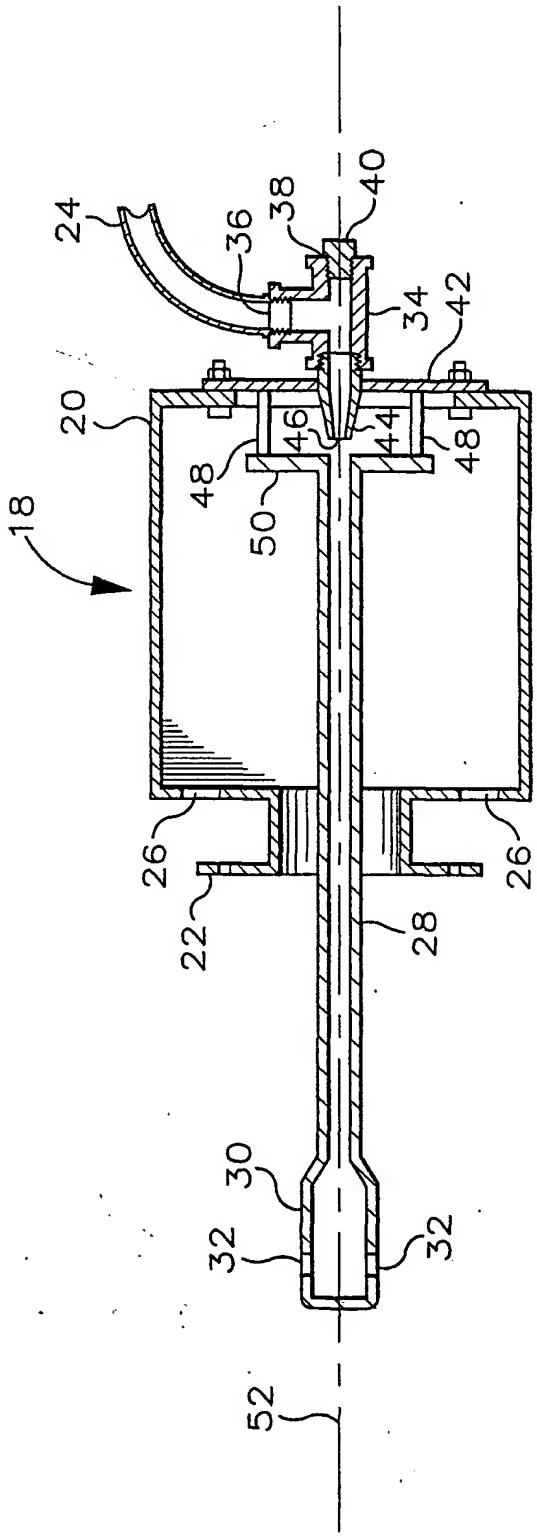

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/30429

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : F23D 11/38
US CL : 431/3, 123; 239/116, 518, 522, 553.5; 134/ 22.18, 37; 15/304

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 431/3, 121, 122, 123; 239/114, 116, 504, 518, 522, 523, 532, 553.5, 567, Dig. 13, Dig. 21; 134/ 22.18, 37; 15/304; 34/439, 104, 105, 106; 122/390

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST BRS search: "sootblower"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y		2-5,7-9,11-18
A	US 5,421,904 A (CARLSON) 06 June 1995 (06.06.1995), see Figs. 1 and 2.	10

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
04 December 2001 (04.12.2001)	28 DEC 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Sara Clarke Telephone No. (703) 308-0861

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